TECHNICAL INFORMATION ON BUILDING MATERIALS

TIBM - 17

FOR USE IN THE DESIGN OF LOW-COST HOUSING

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CORROSION OF METALS USED IN HOUSE CONSTRUCTION

Atmospheric Corrosion of Galvanized Ferrous Sheet Metals.

Technical Information on Building Materials No. 10 of this series entitled, "Atmospheric Corrosion of Ferrous Metals", summarizes outdoor weathering tests conducted by the American Society for Testing Materials to ascertain the durability of bare steel and iron sheets when exposed to rural, seacoastal, and industrial atmospheres. Useful information was obtained on the relative corrosive action of the three types of atmospheres, and on the life that might be expected in such locations from bare 16 and 22-gage steel and iron sheets made of metal with and without added copper.

The present paper (TIBM-17) deals with steel and iron sheets provided with a protective coating. This generally consists of zinc lead, tin or lead-tin alloy. In addition, the sheets are often painted. These various protective measures greatly prolong the useful life of the sheets, particularly when they are used for parts of buildings exposed in locations having severely corrosive atmospheres.

Properties of Metal Coatings.

Since zinc in a coating corrodes faster than iron, a zinc coating will protect the base metal on which it is applied against corrosion even if there are occasional thin spots, holes or scratches in the coating. At such places, if the base metal is exposed, corrosion of the base metal will not occur until the area of the spot of exposed

iron is considerably increased. On the other hand if there are discontinuities in coatings of lead, tin or lead-tin alloy, (terne alloy), the base metal, if exposed, corrodes faster than the coating and may perforate if corrosion continues. Because of this tendency to delay perforation of the base metal at thin places or discontinuities, zinc coatings, ordinarily referred to as galvanizing, have a very general application and usefulness. One practical result of the difference in action between zinc coatings and those of lead, tin or terne, is that painting of a zinc coated sheet for preservation can be delayed considerably longer, if need be, than can the painting of the other types of metal coatings. In most cases lead, tin or terne coated sheets are painted when installed especially for outdoor use.

In order to evaluate zinc coatings of different commercial thicknesses under various conditions of outdoor exposure, the American Society for Testing Materials started an investigation in 1926 on the outdoor weathering of zinc coated (hot-dip galvanized) iron and steel sheets.

Details of American Society for Testing Materials Test.

The base metals were 16 and 22-gage sheets made from steels and irons with and without added copper, these being similar in type to those studied in the atmospheric test of bare metals. The sheets were coated by the hot-dip galvanized process with, respectively, 2.5, 2.0, 1.5, 1.25, and 0.75 ounces of zinc per square foot of sheet. After galvanizing, the sheets were corrugated and cut into 26" x 30" specimens which were exposed on racks at the different test sites. These locations were: Brunot Island in the Ohio River near Pittsburgh, Pennsylvania and Altoona, Pennsylvania, typifying severely corrosive industrial atmospheres; Sandy Hook, New Jersey (foggy, seacoast atmosphere possibly with some industrial contamination); Key West, Florida (tropical seacoast atmosphere); and State College, Pennsylvania (rural atmosphere). Inspections were made at least twice a year and a coating was considered to have failed when the base metal itself rusted at one or more spots.

Results of Test.

The inspections reported to the Society in 1935 show that at Key West, Florida there have been no coating failures after 8.74 years exposure and at State College, Pennsylvania only one coating failure (0.75 ounce coating) after 8.51 years. The results at Brunot Island, Altoona, Pennsylvania and Sandy Hook, New Jersey are summarized in Table I. Inspections of the corroded sheets are being continued to determine the time of perforation. Hence, any conclusions now as to the complete life of the galvanized sheets at the different locations must

be based on the assumption that the life of galvanized sheets is the life of the coating plus the life of the base metal. It is probable that the life of the galvanized sheets is not less than this, and may be more, but a definite statement on this point based on the results of the test itself cannot be made at this time.

Conclusions.

1. The industrial atmospheres were very destructive to all weights of zinc coatings. The foggy contaminated seacoast atmosphere was also severe in its action.

2. The tropical marine atmosphere and especially the rural atmosphere were very mildly corrosive to all the weights of zinc coatings tested.

Recommendations.

From the standpoint of low-maintenance cost it is suggested:

1. At the industrial locations, painting for preservation outdoors of galvanized sheets carrying 0.75 to 1.5 ounces zinc per square foot of sheet should be done a few months after installation and in no case delayed later than three years. If the service permits using sheets with coatings of 2.0 to 2.5 ounces zinc per square foot of sheet, painting should not be delayed later than about the fifth year.

2. At places with atmospheres like Sandy Hook, painting for preservation outdoors of galvanized sheets may be done after one year and should not be delayed later than six years after installation if the coating weight is 1.25 ounces zinc per square foot of sheet. If 2.0 to 2.5 ounce coating is used, painting should not be delayed later than nine years after installation.

3. In rural locations like State College, painting for preservation of galvanized sheets with light coatings (1 ounce per square foot of sheet) may be done the first year but should not be delayed later than nine years after installation. If the heavier coatings are used, painting can be done much later.

4. The paint coat at the various locations must be maintained in good condition.

Table No. 1. Life of Zinc Coatings in Outdoor Exposure Tests Conducted by the American Society for Testing Materials

Thickness of Steel or Iron Base and Thickness of Zinc Coating.	Number of Coated Sheets in Test	Number of Failed Coatings	Percentage of Coatings that Failed	Average of Coatings Life in Years
Brunot Island near Pittsburgh, Pa. (Industrial Type of Atmosphere).				
16-gage, 2.5 oz/sq.ft. of sheet	12	12	100.0	5.18
22 " 2.5 " "	18	18	100.0	5.86
22 " 2.0 " "	18	18	100.0	4.59
22 " 1.5 " "	18	18	100.0	3.49
22 " 1.25 " "	18	18	100.0	3.17
22 " 0.75 " "	14	14	100.0	2.18
Altoona, Pa. (Industrial Type of Atmosphere).				
16-gage, 2.5 oz/sq.ft. of sheet	10	10	100.0	4.37
22 " 2.5 " "	18	18	100.0	4.57
22 " 2.0 " "	18	18	100.0	3.76
22 " 1.5 " "	18	18	100.0	2.97
22 " 1.25 " "	18	18	100.0	2.41
22 " 0.75 " "	18	18	100.0	1.89
Sandy Hook, N. J. (Foggy Seacoast Atmosphere, possibly with some industrial contamination).				
16-gage, 2.5 oz/sq.ft. of sheet	10	none	---	8.74 plus
22 " 2.5 " "	18	none	---	8.74 "
22 " 2.0 " "	18	8	44.4	---
22 " 1.5 " "	18	17	94.4	7.64 *
22 " 1.25 " "	18	18	100.0	6.80
22 " 0.75 " "	14	14	100.0	4.77

*Coating on one sheet out of 18 not yet failed.